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ABSTRACT

This study was designed as the first in a series of inquiries to investigate the use of multidimensional scaling techniques for observing and measuring underlying dimensions commonly perceived by viewers. Following a preliminary study to select photographs, 15 university students aged 19 to 45 were presented with stimuli consisting of 34 colored photographs which illustrated a variety of concepts. Sorting these stimuli into perceptually relevant groups was used as a primary method for recording judgments. Stimuli were presented randomly across pairs and subjects. Three types of data were collected: (1) similarity judgments between pairs of pictures; (2) interview information, including subjects' verbal descriptions of picture groups; and (3) demographic information about subjects. Results suggest that pictures are grouped by viewers according to commonly perceived inherent dimensions within the photograph. Three dimensional aspects--life, nature, and culture--appeared to contain primary visual meaning for subjects, suggesting the existence of a universality of meaning systems in visuals. Fourteen references are listed. (LMM)

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Naturalistic Inquiry: An Example Used in Photographic Research

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Naturalistic Inquiry: An Example Used in Photographic Research

Naturalistic inquiry attempts to describe events in their own terms. Although such methods try to induce as little experimenter bias as possible, early works in anthropology and sociology were primarily descriptive and have been criticized for their lack of objectivity. Experimental studies, while not suffering from the same type of problem, may manipulate variables to such an extent as to lose the integrity of the research question, or to ignore large amounts of available data.

Methods used currently in sociology, anthropology and psychology have begun to add scientific and quantitative dimensions to naturalistic data gathering techniques. Kempton (1981) has devised a method for quantifying significant features of ceramic pots. Szalay and Deese (1978) use an experimental method within a subjective framework to study human attitudes and perceptions. Burton and Romney (1975) employ multidimensional scaling and hierarchical clustering for sorting role terms. Such a sorting task combines naturalistic methods of inquiry with quantifiable data analysis techniques. This last method is particularly useful for analyzing visual and perceptual data and presenting it spatially.

Studies exploring the significance of visuals have been plentiful in the literature (Fleming & Levie, 1978) (Dwyer, 1978). However little attention has been paid to the examination of differences in the perceived meaning of pictures or to the cognitive processes used. The present study was designed as the first in a series of inquiries to investigate the use of multidimensional scaling tehcniques for observing and measuring underlying dimensions commonly perceived by viewers.

SUBJECTS

Fifteen university age students, 19 to 45 years old, were selected for the study. They ranged from having - no previous art background to those having 2 years of graduate study in art. Cultures represented were Anglo, Mexican-American and American Indian.

MATERIALS

Stimuli consisting of 34 colored photographs illustrating a variety of concepts were presented to the subjects. Sorting these stimuli into perceptually relevant groups was used as a primary method for recording judgments. Of the original 100 photographs selected to represent 18 visual categories, the 34 pictures receiving the highest similarity ratings in a pilot program were selected for the final study. Stimuli were then presented randomly across pairs and subjects.

PROCEDURES

Three types of data were collected: 1) Similarity judgements between pairs of pictures 2) Interview information including subjects' verbal descriptions of picture groups, and 3) Demographic information about subjects.

Similarity judgments

Similarity judgments formed the bases for a quantitative, experimental analysis resulting in a multidimensional or spatial representation of the stimulus field. Subjects were given 34 pictures to sort and were told to group them together in any meaningful way they chose. When the task was completed the picture numbers were recorded by group and interview information was collected.

A 34 x 34 individual similarities matrix was constructed for each subject. The lower half of the matrix contained the scores and the diagonal was eliminated. A binary code was used. Each of the 561 similarity ratings was coded as either 1 if the stimuli were paired or 0 if they were not. Individual similarity matrices were summed across subjects and a mean similarity matrix for all subjects was obtained using a special SAS® procedure designed to accommodate similarity ratings (Greenberg, 1983).

The resulting proximities, figures representing the amount of similarity between pictures, were used as the data source for a multidimensional analysis using the ALSCAL technique (Young & Lewyckyj, 1980). Co-ordinates were derived and proximities were plotted in multidimensional space to allow visual inspection of the data.

Multidimensional scaling (MDS) was chosen over factor analysis because factor analysis assumes a linear relationship between variables which is not always appropriate with perceptual data.

Interview information

Quantative data obtained from similarities measures and multidimensional scaling was matched with verbal descriptors provided by the subjects. This resulted in subject generated labels to describe data groups. Adjective descriptors used alone to define contents of a picture are subjective and without structure. Similarity spaces expressed as proximities, however, are mathematically derived and empirically stable. Adjective descriptors used in conjunction with empirical data are of use in interpreting the resultant multidimensional spaces. In addition

judgment of similarities taken directly from subjects is less susceptible to experimenter contamination (Schiffman, Reynolds & Young, 1981.)

Demographic information

Data was collected from subjects regarding age, sex, level of schooling, amount of art background, ethnic community and photographic experience. This information provides data for comparative analysis of perceptual variations between cultures, age groups and educational backgrounds.

RESULTS

The ALSCAL analysis indicated that subjects did indeed group photographs together according to certain similarity traits and that these photographs had recognizable underlying dimensions. The number of co-occurrences of stimulus pairs was determined by first constructing individual similarities matrices for each subject. These individual matrices were then summed across subjects to produce a single matrix of means similarities. The proximities, numbers reflecting the amount of similarity perceived between a pair of photographs, were plotted spatially using the ALSCAL procedure (Young & Lewyckyj, 1980.)

Similarities

Data from the Means Similarities Matrix is summarized in Table 1.

Insert TABLE 1 about here

Of 561 possible pairs, 356 occurred less than 20 percent of the time. However, there were pairs of pictures which consistently were rated together as often as 80 percent of the time. At the upper level, there was 80-100 percent agreement on seven picture pairs. They were

TABLE 1

DATA FROM MEANS SIMILARITIES MATRIX SUMMARIZED BY NUMBER OF CO-OCCURRENCES AND LEVEL

PERCENT	CO-OCCURRENCES
0-19	356
20-39	90
40-59	73
60-79	35
80-100	7
	* 561 Total

* 561 represents the number of pairings in a matrix defined by $\frac{34 \times 34 - 34}{2}$.

numbers 2 and 26, 12 and 17, 12 and 23, 21 and 24, 13 and 17, 20 and 26, and 21 and 34. Pairs 24 and 34, and 17 and 23 had 73 percent agreement. Pictures 12, 17 and 23, which had similar coordinate values were described by respondents as "closeups of people, some showing lots of emotion, and some just riding on machines" (see Figures 1 and 2). Pictures 21, 24 and 34 also had high proximities and similar coordinate values, (Table 2). Initial subject interviews revealed that these were perceived as "pictures of people ... foreigners...Africans".

Multidimensional scaling

Multidimensional analysis of the individual similarity matrices of respondents indicated that the best conceptual space for the picture differences was three dimensional. There was a rapid drop in stress up to three dimensions and a corresponding improvement in squared correlation. The stress value for the two dimensional interpretation (Kruskal's stress formula 1) was .209. The corresponding Rsq was .830. The three dimensional interpretation contained greater information and also coincided with guidelines for selecting dimensionality (Kruskal & Wish, 1978) Higher dimensional solutions did not provide more insight into the data.

The multidimensional results are shown in Table 2 listing stimulus or picture number and corresponding coordinates for each of the three dimensions analyzed.

Insert Table 2 about here

Each dimension was normalized to a mean of 0. The ALSCAL procedure plotted stimulus coordinates and through a succession of iterations fit the proximities to the distances providing a spatial representation of the data, (Figures 1 and 2).

TABLE 2

STIMULUS COORDINATES FROM COMPOSITE MULTIDEMENSIONAL SPACE SIMILARITY RATINGS

Stimulus	Coordinates		
	Dimension 1 Life	Dimension 2 Nature	Dimension 3 Culture
1	1.33	-0.57	-1.47
2	1.52	1.52	0.47
3	-0.59	-0.98	-0.60
4	-0.65	-0.93	0.89
5	-1.20	-0.19	0.19
6	-1.17	0.15	-0.55
7	-1.44	0.16	0.04
8	-1.38	-0.09	-0.01
9	-0.91	-0.45	0.71
10	1.31	-1.79	0.40
11	-0.98	-0.17	-1.04
12	-1.36	0.36	0.11
13	-1.39	0.17	-0.40
14	1.19	0.10	-1.66
15	1.89	0.58	-0.53
16	-0.02	-0.73	-1.49
17	-1.35	0.30	-0.04
18	1.36	-1.69	0.51
19	1.62	1.52	-0.28
20	1.25	1.68	0.45
21	-0.78	0.55	0.81
22	1.15	-0.01	-1.82
23	-1.25	0.16	-0.49
24	-1.06	0.33	0.73
25	1.51	1.64	0.23
26	1.36	1.53	0.36
27	0.34	0.31	1.04
28	1.12	-1.61	0.54
29	-1.40	0.14	0.15
30	1.66	-1.38	0.53
31	1.69	-1.36	0.19
32	-0.56	-0.21	1.07
33	-1.36	0.24	0.12
34	-0.76	0.71	0.85

Interpretation

When multidimensional scaling properly analyzes proximities data from a means similarities matrix, the resultant configuration produces clusters with common properties which are helpful in interpreting underlying dimensions. In this study, interview information elicited from subjects provided the identification of dimensions and clusters of phrases and concepts for coordinates plotted by the ALSCAL procedure. This produced dimensions 1 and 2 (Figure 1) and dimensions 1 and 3 (Figure 2). Subjective inspection of these figures, combined with subject interview information, produced the interpretation which follows. A regression could not be done on this data since the dependent variables were to be identified by the subjects during the study and were not available a priori.

The first dimension (Figure 1) contains close-up pictures of people smiling and frowning opposite pictures of mechanical objects. This dimension was labeled a "living"--"non-living" dimension, as a result of inspection of the pictures and verbal descriptions from subjects. Along the

Insert Figure 1 about here

continuum from left to right are pictures #7 ("close up of a happy couple kissing") and #29 ("medium shot of older woman holding freshly baked muffins and looking worried, apprehensive"). Moving closer to the center is picture #27 ("long shot of person preparing food or cleaning ...other culture...no visible emotion"). Moving to the right along dimension 1 pictures #14 and #22 represent the opposite extreme, perceived as non-living objects. Numbers 14 ("inside of a boat or an airplane")

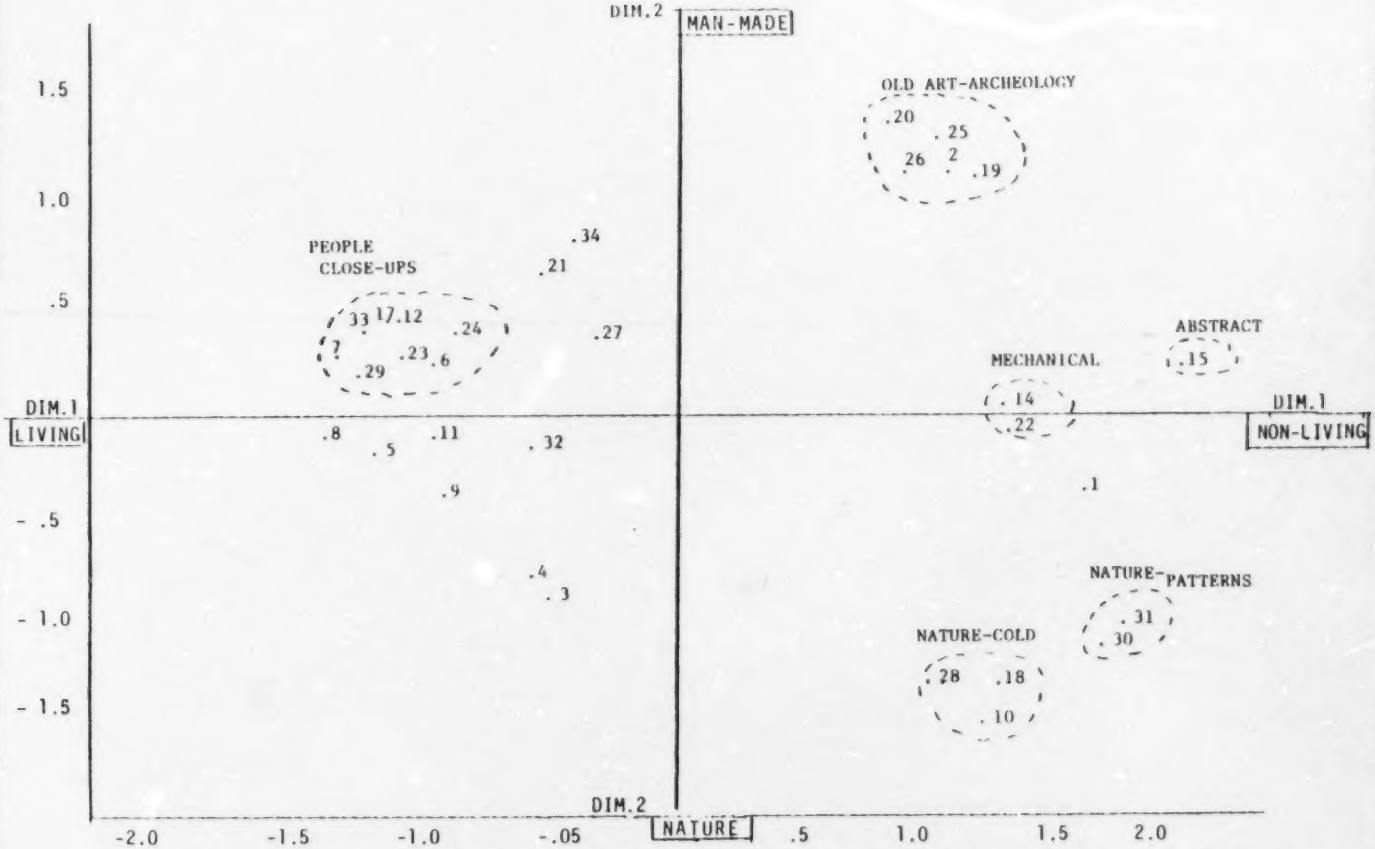

Figure 1. Dimensions 1 and 2 (unrotated) of the three-dimensional space derived by ALSCAL representing relationships between 34 photographs. Interpretation of dimensions and group descriptions obtained from subject interview data.

and 22 (a steam locomotive with lots of energy) represent mechanical, non-living but moving objects. Number 15, the farthest toward the non-living extreme is ("geometric...abstract").

Neighborhood interpretation (Guttman, 1965) reveals that groups of pictures have been described by subjects using similar adjectives. Pictures #33, 17 and 12 are all described as "close-ups of people". Pictures 20, 25 and 26 are seen as "old art and archeology". By further relying on Guttman's (1965) argument for pattern interpretation it can be seen that close-up pictures of people, man-made artifacts, patterns in nature, and nature pictures in snow tend to cluster together in space. Inspection of the data reveals that clusters are small and display a high degree of correspondence. This is verified by the similarities data in Table 2.

Interpretation of the second dimension as "nature---man made" was based on subjects' descriptions and the experimenter's visual inspection of the clusters found at opposite extremes of the dimension (Fig.1). Although farther from the center line, definite groupings are visible. Pictures numbered 20, 25 and 26 represent "a skeleton carved in rock", "a Goya type painting" and "some old pictographs on rock" respectively. Subjects referred to this group as "old artifacts, art and archeology". They are man-made and in the "non-living" quadrant of the dimensional space. As the groupings move from "man-made" to "nature-made", there is a cluster of nature pictures containing leaf patterns and hill contours. Farther toward the extreme, pictures #28, 18 and 10 are nature photographs of "large cold spaces". Dimension 1, the "living---non-living" dimension is complemented by dimension 2 which reveals a "nature-man made" spread.

The 34 pictures group themselves into six neighborhoods thus defining the parameters of the dimensions.

When dimension 1 is plotted with dimension 3 (Figure 2), the pictures of people are broken out into "people like us" and "people not like us". Pictures #21, 34 and 4 suggest people from different cultures.

Insert Figure 2 about here

The dimensional difference is interpreted as "western--non-western" but a broader interpretation for that dimension might be "cultures with modern technology" (pictures 14 and 22) opposed to "cultures without modern technology" (pictures 27 and 32).

Discussion

Dimensions 1 (living---non-living) and 2 (nature---man made) hold up well as shown in the tables and figures. Dimension 3 (western culture ---non-western culture) is weaker but still emerges as a dimension of primary consideration. The results of the analyses suggest that pictures are grouped by viewers according to commonly perceived inherent dimensions within the photograph. Although it is premature to identify the dimensions precisely, areas of universal dimensionality were uncovered which should be tested further.

Three dimensional aspects; life, nature and culture appeared to contain primary visual meaning for the subjects in this study. This suggests the existence of a universality of meaning systems in visuals. Perhaps the structure of connotative meaning in photographs is universal whereas specific visual symbols are culture specific.

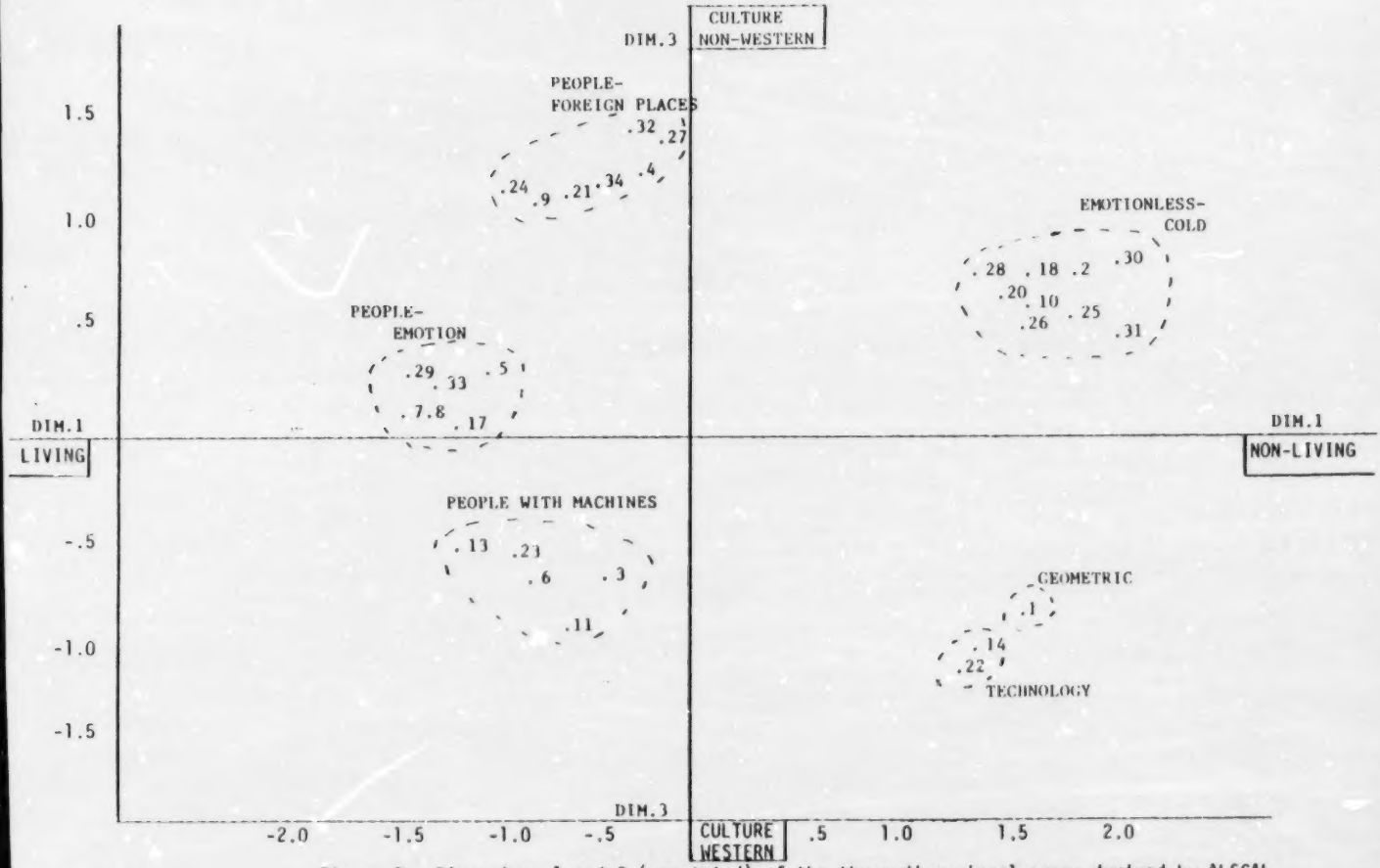

Figure 2. Dimensions 1 and 3 (unrotated) of the three-dimensional space derived by ALSCAL representing relationships between 34 photographs. Interpretation of dimensions and group descriptions obtained from subject interview data.

Concepts similar to this are supported in the areas of linguistics (Osgood, 1963; Miller, 1970) and in visual pattern perception (Deregowski, 1980). Osgood's (1964) semantic differential was the result of discovering three universal factors or dimensions of meaning in the affective domain: evaluative (good-bad), potency (strong-weak) and activity (fast-slow). The results of the present study suggest that there may be universal connotative meanings in pictures as well.

Three directions are suggested for future work in this area. In order to determine whether the dimensions suggested in this study are stable, replication is necessary. First, using the 3 dimensions as 'a priori' categories, the same stimulus set should be used to determine whether subjects continue to place appropriate pictures in the pre-selected categories. Using the 3 dimensions which have emerged in this study as dependent variables, a regression can then be performed to support the multidimensional analysis. Second, another stimulus set of photographs should be selected to include the same wide range of subject matter, and inquiry made to further explore the perceived importance of these dimensions (life, nature and culture) for other visual images. Third, the importance of a cultural dimension suggests eventual cross-cultural studies examining differences in categorization of visual information.

Discovering universal dimensions by which people categorize and attend to visual information is helpful not only in further understanding the perceptual process, but in designing visuals for instruction. Investigating the visual meanings perceived by viewers may lead to a broader understanding of how cognitive processes interact with mediated instruction.

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